



UNITED STATES PATENT AND TRADEMARK OFFICE

UNITED STATES DEPARTMENT OF COMMERCE
United States Patent and Trademark Office
Address: COMMISSIONER FOR PATENTS
P.O. Box 1450
Alexandria, Virginia 22313-1450
www.uspto.gov

APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
-----------------	-------------	----------------------	---------------------	------------------

10/788,730

02/27/2004

Yonjun Jeff Hu

400.084US02

8506

27073

7590

10/11/2005

LEFFERT JAY & POLGLAZE, P.A.

P.O. BOX 581009

MINNEAPOLIS, MN 55458-1009

EXAMINER

COLEMAN, WILLIAM D

ART UNIT

PAPER NUMBER

2823

DATE MAILED: 10/11/2005

Please find below and/or attached an Office communication concerning this application or proceeding.

Office Action Summary

Application No.

10/788,730

Applicant(s)

HU, YONJUN JEFF

Examiner

W. David Coleman

Art Unit

2823

-- The MAILING DATE of this communication appears on the cover sheet with the correspondence address --

Period for Reply

A SHORTENED STATUTORY PERIOD FOR REPLY IS SET TO EXPIRE 3 MONTH(S) OR THIRTY (30) DAYS, WHICHEVER IS LONGER, FROM THE MAILING DATE OF THIS COMMUNICATION.

- Extensions of time may be available under the provisions of 37 CFR 1.136(a). In no event, however, may a reply be timely filed after SIX (6) MONTHS from the mailing date of this communication.
- If NO period for reply is specified above, the maximum statutory period will apply and will expire SIX (6) MONTHS from the mailing date of this communication.
- Failure to reply within the set or extended period for reply will, by statute, cause the application to become ABANDONED (35 U.S.C. § 133). Any reply received by the Office later than three months after the mailing date of this communication, even if timely filed, may reduce any earned patent term adjustment. See 37 CFR 1.704(b).

Status

- 1) ☒ Responsive to communication(s) filed on 28 July 2005.
- 2a) ☒ This action is **FINAL**. 2b) ☐ This action is non-final.
- 3) ☐ Since this application is in condition for allowance except for formal matters, prosecution as to the merits is closed in accordance with the practice under *Ex parte Quayle*, 1935 C.D. 11, 453 O.G. 213.

Disposition of Claims

- 4) ☒ Claim(s) 1-45 is/are pending in the application.
- 4a) Of the above claim(s) _____ is/are withdrawn from consideration.
- 5) ☒ Claim(s) 23-31 and 49-54 is/are allowed.
- 6) ☒ Claim(s) 1-22 and 32-48 is/are rejected.
- 7) ☐ Claim(s) _____ is/are objected to.
- 8) ☐ Claim(s) _____ are subject to restriction and/or election requirement.

Application Papers

- 9) ☐ The specification is objected to by the Examiner.
- 10) ☐ The drawing(s) filed on _____ is/are: a) ☐ accepted or b) ☐ objected to by the Examiner.
Applicant may not request that any objection to the drawing(s) be held in abeyance. See 37 CFR 1.85(a).
Replacement drawing sheet(s) including the correction is required if the drawing(s) is objected to. See 37 CFR 1.121(d).
- 11) ☐ The oath or declaration is objected to by the Examiner. Note the attached Office Action or form PTO-152.

Priority under 35 U.S.C. § 119

- 12) ☐ Acknowledgment is made of a claim for foreign priority under 35 U.S.C. § 119(a)-(d) or (f).
- a) ☐ All b) ☐ Some * c) ☐ None of:
1. ☐ Certified copies of the priority documents have been received.
 2. ☐ Certified copies of the priority documents have been received in Application No. _____.
 3. ☐ Copies of the certified copies of the priority documents have been received in this National Stage application from the International Bureau (PCT Rule 17.2(a)).

* See the attached detailed Office action for a list of the certified copies not received.

Attachment(s)

- | | |
|------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------|
| 1) <input checked="" type="checkbox"/> Notice of References Cited (PTO-892) | 4) <input type="checkbox"/> Interview Summary (PTO-413)
Paper No(s)/Mail Date. _____ |
| 2) <input type="checkbox"/> Notice of Draftsperson's Patent Drawing Review (PTO-948) | 5) <input type="checkbox"/> Notice of Informal Patent Application (PTO-152) |
| 3) <input type="checkbox"/> Information Disclosure Statement(s) (PTO-1449 or PTO/SB/08)
Paper No(s)/Mail Date _____ | 6) <input type="checkbox"/> Other: _____ |

DETAILED ACTION

Response to Arguments

1. Applicant's arguments filed July 28, 2005 have been fully considered but they are not persuasive.
2. Applicant contends that Rathore et al., U.S. Patent 6,258,710 herein known as Rathore fails to teach the limitations of claims 1-7, 11-17 and 32-36. Specifically, Applicant contends that Rathore fails to teach a crystalline compound because the term "crystalline" is not found in the disclosure of Rathore.
3. In response to Applicant's contention that Rathore fails to teach the claimed limitation and in particular "forming a crystalline compound with the first metal component" please note that it is well known that metals in the solid phase are highly crystalline. As for the crystalline compound, the Examiner has provided an article titled "Intermetallic compound formations in titanium-copper thin-film couples" J.L. Liotard et al., Journal of Applied Physics, Vo. 57, issue 6, pp 1895-900, March 15, 1985. This article explicitly details the formation and phases of the titanium-copper compound. The article implies and discloses that when copper and titanium are near each other there forms a layer of titanium, a layer of titanium-copper and a layer of titanium-copper subscript 3 i.e., TiCu_3 . Applicant is merely reciting what is already known in the art as to the crystalline compound formation between titanium and copper and therefore because Applicant has not discovered anything new in the claim limitation of claim 1, Applicant's argument is moot.

Art Unit: 2823

4. Applicant's arguments for claims 14, 15, 16-17, 32 as well as 33-36 are addressed in the response to arguments in the discussion above and therefore Applicant's arguments are moot with regard to the term "crystalline compound".

Claim Rejections - 35 USC § 102

5. The following is a quotation of the appropriate paragraphs of 35 U.S.C. 102 that form the basis for the rejections under this section made in this Office action:

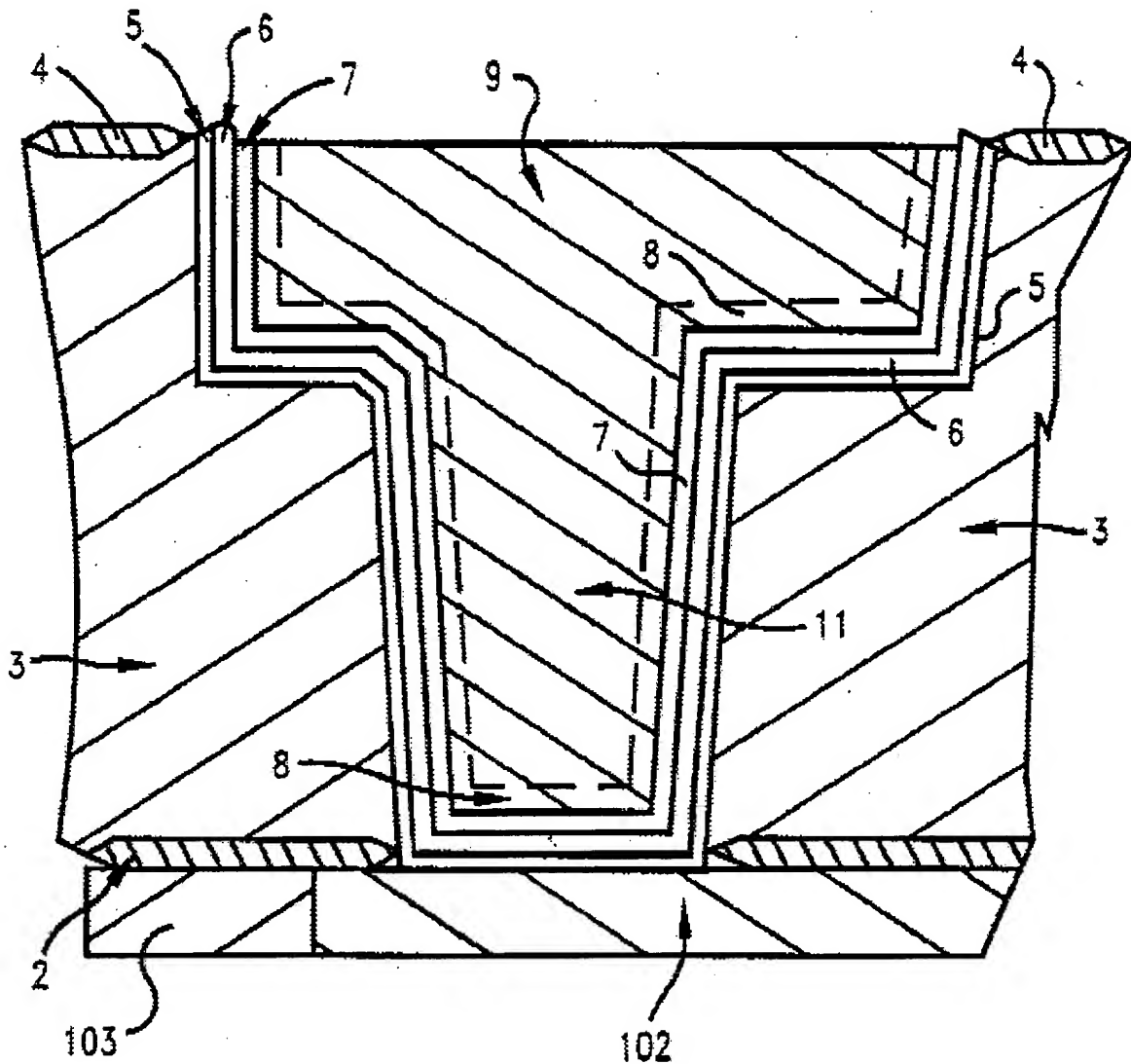
A person shall be entitled to a patent unless –

(e) the invention was described in a patent granted on an application for patent by another filed in the United States before the invention thereof by the applicant for patent, or on an international application by another who has fulfilled the requirements of paragraphs (1), (2), and (4) of section 371(c) of this title before the invention thereof by the applicant for patent.

6. The changes made to 35 U.S.C. 102(e) by the American Inventors Protection Act of 1999 (AIPA) and the Intellectual Property and High Technology Technical Amendments Act of 2002 do not apply when the reference is a U.S. patent resulting directly or indirectly from an international application filed before November 29, 2000. Therefore, the prior art date of the reference is determined under 35 U.S.C. 102(e) prior to the amendment by the AIPA (pre-AIPA 35 U.S.C. 102(e)).

7. Claims 1, 2, 3, 4, 5, 6, 7, 11, 12, 13, 14, 15, 16, 17, 32, 33, 34, 35 and 36 are rejected under 35 U.S.C. 102(e) as being anticipated by Rathore et al., U.S. Patent 6,258,710 B1.

8. Rathore discloses a semiconductor device as claimed. See **FIGS. 1-8** where Rathore teaches the following limitations.



9. Pertaining to claim 1, Rathore teaches an interconnect of an integrated circuit device, comprising.

a diffusion barrier layer 5;

a first metal layer on the diffusion barrier layer 6/7, wherein the first metal layer comprises a first metal component and a second metal component 8 forming a crystalline compound with the first metal component, wherein the second metal component has a surface energy lower than a

Art Unit: 2823

surface energy of the first metal component, and wherein the crystalline compound is rich in the first metal component; and
a second metal layer on the first metal layer, wherein the second metal layer comprises the first metal component.

10. Pertaining to claim 2, Rathore teaches the interconnect of claim 1, wherein the diffusion barrier layer is a titanium-containing layer.

11. Pertaining to claim 3, Rathore the interconnect of claim 1, wherein the diffusion barrier layer is titanium nitride.

12. Pertaining to claim 4, Rathore teaches the interconnect of claim 1, wherein the first metal component is selected from the group consisting of copper, silver, gold, palladium, platinum, rhenium, iridium, ruthenium and osmium.

13. Pertaining to claim 5, Rathore The interconnect of claim 1, wherein the second metal component is selected from the group consisting of scandium, yttrium, lanthanum, titanium, zirconium and hafnium.

14. Pertaining to claim 6, Rathore teaches the interconnect of claim 1, wherein the first metal layer further comprises a third metal component forming a second crystalline compound with the first metal component, wherein the third metal component is different from the second metal

Art Unit: 2823

component, wherein the third metal component has a surface energy lower than a surface energy of the first metal component, and wherein the second crystalline compound is rich in the first metal component.

15. Pertaining to claim 7, Rathore teaches a portion of an integrated circuit device, comprising:

a dielectric layer overlying a base layer; a layer of titanium nitride overlying the dielectric layer; a first metal layer on the layer of titanium nitride, wherein the first metal layer comprises a crystalline alloy compound containing a first metal component and a second metal component, wherein the second metal component is selected from the group consisting of Group IIIA and Group IVA elements, and wherein an atomic ratio of the first metal component to the second metal component in the first metal layer is greater than one; and a second metal layer on the first metal layer, wherein the second metal layer comprises the first metal component.

16. Pertaining to claim 11, Rathore teaches the portion of an integrated circuit device of claim 7, wherein the layer of titanium nitride is adjoining a portion of the dielectric layer.

17. Pertaining to claim 12, Rathore teaches the portion of an integrated circuit device of claim 11, wherein the layer of titanium nitride is further adjoining a portion of the base layer.

Art Unit: 2823

18. Pertaining to claim 13, Rathore teaches the portion of an integrated circuit device of claim 7, wherein the base layer is selected from the group consisting of a semiconductor substrate and a conductor layer.

19. Pertaining to claim 14, Rathore teaches an interconnect of an integrated circuit device, comprising:

a titanium nitride layer;

a first metal layer on the titanium nitride layer, wherein the first metal layer comprises copper and a metal component forming a crystalline compound with the copper, wherein the metal component is selected from the group consisting of scandium, yttrium, lanthanum, titanium, zirconium and hafnium, and wherein the crystalline compound has an atomic ratio of copper to the metal component in the first metal layer of greater than one; and

a second metal layer on the first metal layer, wherein the second metal layer comprises copper.

20. Pertaining to claim 15, Rathore teaches a portion of an integrated circuit device, comprising:

a layer of titanium nitride adjoining a dielectric layer;

a metal layer on the layer of titanium nitride, wherein the metal layer comprises a copper-rich alloy selected from the group consisting of Cu₄Sc, Cu₆Y, Cu₄Ti, Cu₃Ti and CuSZr; and

a copper layer on the metal layer.

Art Unit: 2823

21. Pertaining to claim 16, Rathore teaches the portion of an integrated circuit device of claim 15, wherein the copper-rich alloy has a crystalline structure.

22. Pertaining to claim 17, Rathore teaches the portion of an integrated circuit device of claim 15, wherein the metal layer further comprises elemental copper.

23. Pertaining to claim 32, Rathore teaches an interconnect of an integrated circuit device, comprising:

a diffusion barrier layer;

a layer of a metal alloy nitride on the diffusion barrier layer, wherein the layer of metal alloy nitride comprises a first metal component, a second metal component that can form a crystalline compound with the first metal component, and

nitrogen, wherein the second metal component has a surface energy lower than a surface energy of the first metal component, and wherein the nitrided metal layer is rich in the first metal component; and

a second metal layer on the layer of metal alloy nitride, wherein the second metal layer comprises the first metal component.

24. Pertaining to claim 33, Rathore teaches The interconnect of claim 32, wherein the diffusion barrier layer is a titanium containing layer.

Art Unit: 2823

25. Pertaining to claim 34, Rathore teaches the interconnect of claim 32, wherein the diffusion barrier layer is titanium nitride.

26. Pertaining to claim 35, Rathore teaches the interconnect of claim 32, wherein the first metal component is selected from the group consisting of copper, silver, gold, palladium, platinum, rhenium, iridium, ruthenium and osmium.

27. Pertaining to claim 36, Rathore teaches the interconnect of claim 32, wherein the second metal component is selected from the group consisting of scandium, yttrium, lanthanum, titanium, zirconium and hafnium.

Claim Rejections - 35 USC § 103

28. The following is a quotation of 35 U.S.C. 103(a) which forms the basis for all obviousness rejections set forth in this Office action:

(a) A patent may not be obtained though the invention is not identically disclosed or described as set forth in section 102 of this title, if the differences between the subject matter sought to be patented and the prior art are such that the subject matter as a whole would have been obvious at the time the invention was made to a person having ordinary skill in the art to which said subject matter pertains. Patentability shall not be negated by the manner in which the invention was made.

29. Claims 8, 9, 10, 18, 19, 20, 21, 22 and 37-48 are rejected under 35 U.S.C. 103(a) as being unpatentable over Rathore et al., U.S. Patent 6,258,710 B1.

30. Given the teaching of the references, it would have been obvious to determine the optimum thickness, temperature as well as condition of delivery of the layers involved. See *In re Aller, Lacey and Hall* (10 USPQ 233-237) "It is not inventive to discover optimum or workable ranges by routine experimentation. Note that the specification contains no disclosure of either the critical nature of the claimed ranges or any unexpected results arising therefrom. Where

Art Unit: 2823

patentability is said to be based upon particular chosen dimensions or upon another variable recited in a claim, the Applicant must show that the chosen dimensions are critical. *In re Woodruff*, 919 F.2d 1575, 1578, 16 USPQ2d 1934, 1936 (Fed. Cir. 1990).

Any differences in the claimed invention and the prior art may be expected to result in some differences in properties. The issue is whether the properties differ to such an extent that the difference is really unexpected. *In re Merck & Co.*, 800 F.2d 1091, 231 USPQ 375 (Fed. Cir. 1986)

Appellants have the burden of explaining the data in any declaration they proffer as evidence of non-obviousness. *Ex parte Ishizaka*, 24 USPQ2d 1621, 1624 (Bd. Pat. App. & Inter. 1992).

An Affidavit or declaration under 37 CFR 1.132 must compare the claimed subject matter with the closest prior art to be effective to rebut a prima facie case of obviousness. *In re Burckel*, 592 F.2d 1175, 201 USPQ 67 (CCPA 1979).

Allowable Subject Matter

31. Claims 23-31 and 49-54 allowed.

32. The following is an examiner's statement of reasons for allowance: the prior art does not anticipate nor render obviousness as to providing a silver layer for the integrated circuit.

33. Any comments considered necessary by applicant must be submitted no later than the payment of the issue fee and, to avoid processing delays, should preferably accompany the issue fee. Such submissions should be clearly labeled "Comments on Statement of Reasons for Allowance."

Conclusion

34. **THIS ACTION IS MADE FINAL.** Applicant is reminded of the extension of time policy as set forth in 37 CFR 1.136(a).

35. A shortened statutory period for reply to this final action is set to expire **THREE MONTHS** from the mailing date of this action. In the event a first reply is filed within **TWO MONTHS** of the mailing date of this final action and the advisory action is not mailed until after the end of the **THREE-MONTH** shortened statutory period, then the shortened statutory period will expire on the date the advisory action is mailed, and any extension fee pursuant to 37 CFR 1.136(a) will be calculated from the mailing date of the advisory action. In no event, however, will the statutory period for reply expire later than **SIX MONTHS** from the mailing date of this final action.

36. Any inquiry concerning this communication or earlier communications from the examiner should be directed to W. David Coleman whose telephone number is 571-272-1856. The examiner can normally be reached on Monday-Friday 9:00 AM - 5:30 PM.

37. If attempts to reach the examiner by telephone are unsuccessful, the examiner's supervisor, Olik Chaudhuri can be reached on 571-272-1855. The fax phone number for the organization where this application or proceeding is assigned is 571-273-8300.

Art Unit: 2823

38. Information regarding the status of an application may be obtained from the Patent Application Information Retrieval (PAIR) system. Status information for published applications may be obtained from either Private PAIR or Public PAIR. Status information for unpublished applications is available through Private PAIR only. For more information about the PAIR system, see <http://pair-direct.uspto.gov>. Should you have questions on access to the Private PAIR system, contact the Electronic Business Center (EBC) at 866-217-9197 (toll-free).



W. David Coleman
Primary Examiner
Art Unit 2823

WDC